

What is claimed is:

1 1. A method for identifying components of a sample mixture in a Fourier
2 transform ion cyclotron resonance mass spectrometer (FT-ICR MS) having a FT-ICR MS
3 chamber, the components having respective ionization potentials defining a range of
4 ionization potentials, the method comprising the steps of:

5 selecting a first ionic partner having an ionization potential within the range of
6 ionization potentials;

7 introducing the first ionic partner into the FT-ICR MS chamber;

8 introducing the sample mixture into the FT-ICR MS chamber, whereby a charge
9 exchange reaction takes place in the chamber between the first ionic partner and those
10 components of the sample mixture having ionization potentials below the ionization
11 potential of the first ionic partner, forming a first ionized mixture; and

12 detecting the ionized components of the first ionized mixture in the FT-ICR MS
13 chamber.

1 2. The method of claim 1, wherein the ionization potential of the first
2 ionic partner is about 9.3 electron volts.

1 3. The method of claim 1, wherein the first ionic partner is an ionized gas
2 selected from the group consisting of pyridine, nitrogen oxide and 1,2 difluorobenzene.

1 4. The method of claim 1, wherein the step of introducing a first ionic
2 partner comprises bombarding a neutral reagent gas with electrons within the chamber.

1 5. The method of claim 1, wherein the sample mixture is introduced into
2 the FT-ICR MS chamber and the charge exchange reaction takes place at a pressure of
3 less than 10^{-6} torr.

1 6. The method of claim 1, wherein the detection step takes place in the
2 FT-ICR MS chamber at a pressure less than 10^{-9} torr.

1 7. The method of claim 1, further comprising the steps of:
2 selecting a second ionic partner having an ionization potential greater than that of
3 the first ionic partner;
4 introducing the second ionic partner into the FT-ICR MS chamber;
5 introducing the sample mixture into the FT-ICR MS chamber, whereby a charge
6 exchange reaction takes place in the chamber between the second ionic partner and those
7 components of the sample mixture having ionization potentials below the ionization
8 potential of the second ionic partner, forming a second ionized mixture;
9 detecting the ionized components of the second ionized mixture in the FT-ICR
10 MS chamber; and
11 comparing results obtained in the detection of the ionized components of the first
12 and second ionized mixtures.

1 8. The method of claim 7, wherein the ionization potential of the second
2 ionic partner is greater than about 14 electron volts.

1 9. The method of claim 7, wherein the second ionic partner is selected
2 from the group consisting of CO, N₂ and SiF₄.

1 10. The method of claim 7, wherein the second ionic partner has an
2 ionization potential greater than that of each of the components of the sample mixture.

1 11. The method of claim 7, wherein the step of comparing results obtained
2 in the detection of the ionized components of the first and second ionized mixtures
3 includes using results obtained in the detection of the ionized components of the first
4 ionized mixture, to identify components appearing in the results obtained in the detection
5 of the ionized components of the second ionized mixture.

1 12. The method of claim 7, wherein the step of comparing results includes
2 identifying a component of the mixture based on information from the results from the
3 detection steps and using an ionization potential of the component.

1 13. The method of claim 7, wherein all steps in the process are completed
2 in less than two seconds.

1 14. An apparatus for identifying components of a sample mixture, the
2 components having respective ionization potentials defining a range of ionization
3 potentials, the apparatus comprising:

4 a chamber;

5 at least one inlet with a sample injection valve opening to the chamber for
6 introducing pulses of the sample mixture and of first and second reagent gasses;

7 excitation plates in the chamber for inducing orbital motion of ionized
8 components within the chamber;

9 detecting plates for detecting the ionized components in the chamber;

10 an electron source for directing electrons into the chamber;
11 a controller configured to control the sample injection valve, the excitation plates,
12 the detection plates and the electron source; the controller including a computer readable
13 medium with executable instructions for performing the steps of introducing a pulse of
14 first reagent gas through the inlet, ionizing the first reagent gas by actuating the electron
15 source; admitting a pulse of the sample mixture through the inlet, inducing an orbital
16 motion with the excitation plates and detecting orbiting molecules with the detection
17 plates, and repeating the steps using the second reagent gas.

1 15. The apparatus of claim 14, wherein the ionization potential of the first
2 reagent gas is about 9.3 electron volts.

1 16. The apparatus of claim 15, wherein the first reagent gas is selected
2 from the group consisting of pyridine, nitrogen oxide and 1,2 difluorobenzene.

1 17. The apparatus of claim 14, wherein the executable instructions further
2 include the step of controlling a gas introduction pulse size of the sample injection valve
3 to introduce the sample mixture into the chamber at a pressure less than 10^{-6} torr.

1 18. The apparatus of claim 14, wherein the executable instructions further
2 include the step of controlling a gas introduction pulse size of the sample injection valve
3 such that the orbiting molecules are detected at a pressure less than 10^{-9} torr.

1 19. The apparatus of claim 14, wherein the ionization potential of the
2 second reagent gas is greater than about 14 electron volts.

1 20. The apparatus of claim 19, wherein the second reagent gas is selected
2 from the group consisting of CO, N₂ and SiF₄.

1 21. The apparatus of claim 14, wherein the second reagent gas has an
2 ionization potential greater than that of each of the components of the sample mixture.

1 22. The apparatus of claim 14, wherein the executable instructions further
2 include the step of comparing results obtained in the detection of the orbiting molecules
3 produced with the first reagent gas with those produced with the second reagent gas.

1 23. The apparatus of claim 22, wherein the step of comparing results
2 obtained in the detection of the orbiting molecules produced with the first and second
3 reagent gasses includes using results obtained in the detection of the orbiting molecules
4 produced with the first reagent gas, to identify components appearing in the results
5 obtained in the detection of the orbiting molecules produced with the second reagent gas.

1 24. The apparatus of claim 22, wherein the step of comparing results
2 includes identifying a component of the mixture based on information from the results
3 from the detection steps and using an ionization potential of the component.